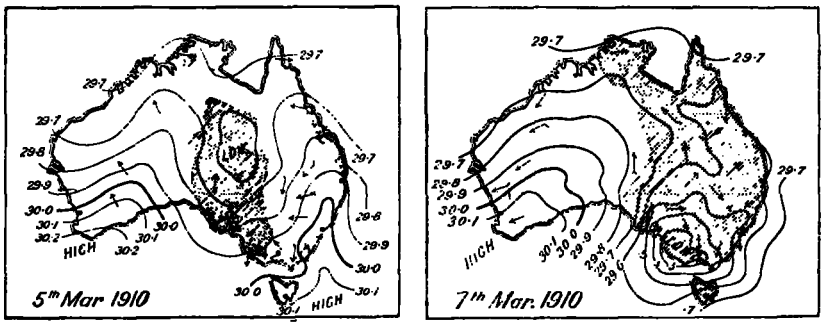
copious rain. At many points there a fall of more than 20 inches has been received within 24 hours, and several times falls in excess of 30 inches have occurred. An oval area 20 by 85 miles receives an annual average of more than 100 inches. One point (Harvey Creek) has a 19-year average of 163.7 inches.

This memoir with its 183 maps and diagrams and its 74 tables requires much more than the foregoing summary to be fully appreciated. It is an important piece of work well done. It would have been improved, however, by summaries, and index, and perhaps by the use of fuller base maps. No two of the larger maps of Australia are on the same scale, or on the same base; reference points and lines are quite inadequate on most



FIGS. 9, 10.—Australian weather maps: Tongue developing into cyclone, and cyclone forming at tip of tongue. (Rainfall indicated by shading.)

of these maps, and on the weather maps for intercomparison. Nevertheless, in each one the features shown are very clear.

CLIMOGRAPH CHARTS.[1]

By Sir NAPIER SHAW.

[Abstract.]

That the climographs, prepared by Dr. Griffith Taylor, which attempt to give graphically an idea of the climatic conditions of a locality by means of plotting relative humidity against the wet bulb temperature, are not the first attempt of this kind, is a fact that should be noted. Dr. John Ball, of the Egyptian survey department, in the Cairo Scientific Journal, vol. 1, No. 4, made use of similar diagrams, using the dry-bulb temperatures. The use of the dry-bulb temperature instead of the wet does no more than alter the position on the sheet and makes little difference in the general appearance of the diagram.

"As a matter of fact, neither form of diagram seems to be completely satisfying as distinguishing between the comfortable, the tolerable, and the unendurable in climate. Some years ago Mr. W. F. Tyler, of the Chinese customs service, pointed out that between the limits of temperature, say, 55° F. and 65° F., nobody minded much what the humidity was; but outside these limits of the 'generally comfortable' there was a range of temperatures of the 'just tolerable' order for damp air, which soon got the 'unendurable' on the side of the higher temperature. Beyond these, again, is a range of temperatures under which life is possible only in dry air. An effective climatic diagram would in some way or other exhibit the relation of the climate to the ranges compatible with comfort, life, and death."—*C. L. M.*

[1] *Nature*, London, Jan. 16, 1919, No. 2508, vol. 102, p. 383.

A NEW INTERPRETATION OF THE RELATIONSHIPS OF TEMPERATURE AND HUMIDITY TO INSECT DEVELOPMENT.[1]

By Dr. W. DWIGHT PIERCE, Bureau of Entomology.

[Abstract.]

"Upon the proper interpretation of the laws of climatic control of life rests the solution of many practical problems, and inasmuch as all plant and animal life reacts to climate in the same general manner it is apparent that

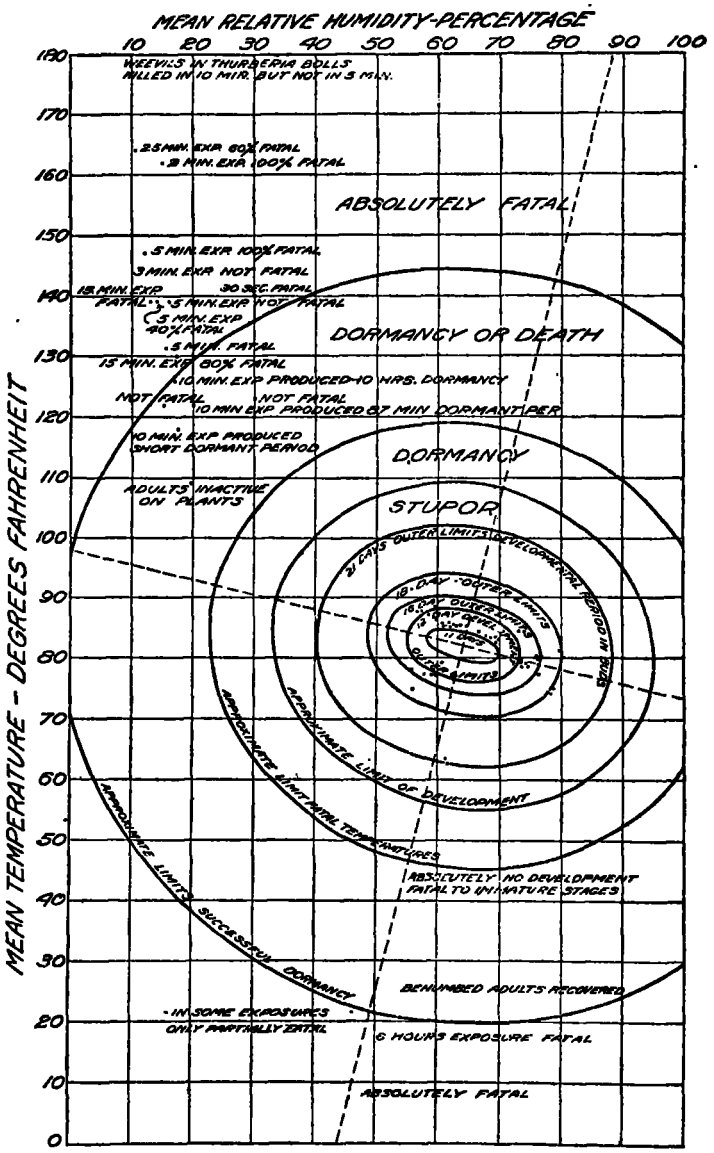


FIG. 1.—Graph showing the relations of temperature and humidity to cotton boll-weevil activity.

the study of the climatic control of insect development may throw light upon the problems of all other forms of life."

Mr. Pierce thus opens his discussion of the relationship problem, and further notes that all so-called theoretical laws of effective temperature for all life do not properly explain many of the phenomena that are observed. The former theory of a fixed zero of effective temperature, so long maintained by biologists, is only in recent years rejected upon the findings that each species might have a different zero. In addition, it is only recently that the factor of humidity has been definitely used in the solution

[1] Jour. Agr. Research, Dept. of Agr., Washington, Mar. 20, 1916, pp. 1183-1191.

of the problem. Thus the effective zero has become the point at which metabolism begins for any type at a given relative humidity.

The greater mass of investigations, from which the earlier theories were derived, were made in north temperate regions where the effects of low temperatures were noted predominantly, and those of high temperatures comparatively little observed. The present studies were made by the writer of the paper and Mr. W. D. Hunter while in charge of a cotton boll-weevil force operating principally in Texas and Louisiana from 1902 to 1915. Thermohygrograph records of the free air were kept during the experiments, and artificial high and low temperature investigations were conducted, the former with "definite humidity control in order to determine the effects of heat" upon the boll-weevil. The diagram (fig. 1) expresses zone relationship found between temperature and humidity and the life activities of the insect from metabolism to death. A study of the cases of thousands of weevils taken individually disclosed their maximum efficiency to lie approximately at an average temperature of 83° F. and 65 per cent relative humidity. The temperatures and humidities at which dormancy and death ensue cover a wide range of absolute extremes.

The writer confesses to much difficulty in arriving at his first zero, since "only by a laborious series of testings can [it] * * * be approximated, unless the worker finds it by a fortunate chance." All the records of a given average humidity were tabulated together, and the zones of effective temperatures had to be arrived at individually for each moisture per cent.— *W. E. H.*

THE USE OF THE CLIMOGRAPH AS A TEST FOR WEATHER.

By M. M'CALLUM FAIRGRIEVE.[1]

(Author's Summary.)

Summing up these observations we may say that while the yearly climographs of a district or districts may resemble each other, the climographs from year to year, in Western Europe at all events, are widely different.

The very variability of the climograph may be one of the important and omitted factors of the question; the climograph in fact seems even more useful as a test of weather than as a test of climate. If a place or district has a very variable climate, its average climograph for a number of years may be of relatively small size, and may thus give the impression of a climate with but slight variations; its beneficial irregularities may not tell, while another place with but slight variations from normal will seem more comfortable than it is. And so, while welcoming the appearance of the climograph for the general average conditions as used by Dr. Taylor, it seems still more useful as a representation of the shorter period.

A typical climograph should not be based too much upon town readings; but one test of a natural region in this connection is the resemblance of climographs of individual stations in it.

Perhaps an instrument which continuously recorded for a month or year on a fixed sheet of paper the climograph coordinates, relative humidity and temperature, would be a useful variation of the climograph idea, as it would give the definite unaveraged facts for each station. Of course the resulting continuous curves drawn by the pen of the instrument would overlap; but the picture would give not only particulars of temperature and humidity, but also a good idea of their variabilty, i. e., it would give practically three sets of coordinates on one sheet of paper.

A word of warning may not be amiss that the average yearly conditions are not given by the centroid of the climograph as might be hastily assumed; the diagrams have no time coordinates, and points close together have not the effect of weighting the observations toward themselves. Thus in climographs for Scotland the points representing the winter months tend to come together about 40°, but the average looks as if it were very much higher.

[1] Jour. Scottish Meteorological Soc., 1916, vol. 17, pp. 148–155.